

1968

Comparative Appraisal of Bone, Fat, and Muscle Development of Minnesota White and Indian School Children

Rita A. Kroska
University of Minnesota

Follow this and additional works at: <https://digitalcommons.morris.umn.edu/jmas>



Part of the [Nutrition Commons](#)

Recommended Citation

Kroska, R. A. (1968). Comparative Appraisal of Bone, Fat, and Muscle Development of Minnesota White and Indian School Children. *Journal of the Minnesota Academy of Science*, Vol. 35 No. 1, 51-56.
Retrieved from <https://digitalcommons.morris.umn.edu/jmas/vol35/iss1/14>

This Article is brought to you for free and open access by the Journals at University of Minnesota Morris Digital Well. It has been accepted for inclusion in Journal of the Minnesota Academy of Science by an authorized editor of University of Minnesota Morris Digital Well. For more information, please contact skulann@morris.umn.edu.

Comparative Appraisal of Bone, Fat, and Muscle Development Of Minnesota White and Indian School Children

RITA A. KROSKA, PH.D.*

ABSTRACT—Comparative analysis of the nutritional status of white and Indian children living in an "economically distressed" area in Northern Minnesota was carried out by assessment of skeletal, fat, and muscle development and by dietary records from a limited sample of the subjects. Diets of the two groups were found to be roughly equivalent in caloric, protein, fat, and carbohydrate content; and the average heights and weights were generally similar. Yet the white children were on the whole fatter and had either equivalent or greater muscle development than the Indian children while the Indians tended to have more robust skeletons. Though physical activity levels were not assessed, the nature of variations detected in body composition suggests a genetic basis for the differences.

Studies concerned with comparative assessment of the nutritional status of North American white and Indian children are limited not only in number but also in content. At the time of this writing, three such studies are known. Wissler (1911) compared the height, weight, and chest circumference of Dakota tribe children with statistics on white children as measured by Franz Boas. Steggerda and Densen (1936) compared the height and weight of Navajo Indian children and Dutch white children. Krause (1954) compared the height and weight of Apache, Pima and Papago Indian children with the height and weight of white school children in the southwestern United States. However, use of those parameters correlated with age reveals relatively little about the tissue components which make up the total body mass. In order to come to a closer definition of differences in physical development, consideration must be given to the variation in skeletal, fat, and muscle development related to differing genetic, regional, and socio-economic backgrounds, which this study attempts to do with respect to white and Indian school children from Northern Minnesota.

Subject Material

Anthropometry was carried out on 257 white children (111 boys and 146 girls) from Blackduck, Minnesota, and 537 Chippewa Indian children (282 boys and 255 girls) from the Red Lake Indian Reservation, also in Northern Minnesota. The subjects ranged in age from 6 through 12 years, and all attended school within the same geographical region in the north central part of the state. The area had been classified as "economically distressed" by the Area Redevelopment Administration in 1964.

The Indian children represented 95 per cent of the Red Lake Band population within the age group selected for the study, and the white children represented 70 per

cent of the Blackduck school population in the same age group. The smaller percentage in the white group was due primarily to parental disinterest in the research-project, hence inferences which might be made from this study should take the sampling into consideration. The samples were further divided into three age groups. Group A included those from 6 to 8 years old; group B from 8 to 10 years; and group C from 10 through 12.

Nutrition

All the children were apparently healthy at the time, and no detailed analysis of their nutrition was attempted. However, three-day food records were obtained from random samples of 16 white children and 16 Indian children, equally divided by sex and 11 through 12 years of age. It was assumed that any major differences in the dietary conditions which might affect the anthropometric measurements would be reflected in this sample.

Under the supervision of classroom teachers, the children recorded the kinds and amounts of food eaten on three consecutive days, Sunday, Monday and Tuesday. The dietary intakes were analyzed for the following constituents: (1) total calories; (2) protein in grams and as per cent of total calories; (3) fat in grams and as per cent of total calories; and (4) carbohydrates in grams and as per cent of total of total calories. The *United States Department of Agriculture Handbook No. 8* (1963) and Church and Church (1963) were consulted for baseline information to determine food composition.

Procedure

The anthropometric measurements of this study correspond in large part to recommendations for assessing nutritional status (Committee on Nutritional Anthropometry, 1956). These measurements were weight, height, sitting height, bicristal diameter, bi-epicondylar diameter of the humerus, bi-epicondylar diameter of the femur, upper arm circumference, calf circumference; and the upper arm dorsal, subscapular, calf, and iliac crest skinfolds. All limb and skinfold measurements, done by the author, were taken on the subject's right side. The children were shoeless and dressed only in their underwear when measured.

*Rita A. Kroska is assistant professor for Public Health Nursing in the School of Public Health of the University of Minnesota. She received the R. N. certificate from the St. Cloud Hospital School of Nursing, a Master of Public Health degree from the University of Minnesota in 1961 and a Ph.D. in anthropology from University of Minnesota in 1965. She is also a staff member of the Systems Development Project, a federal Children's Bureau program.

Weight was taken on a vertical platform scale to the nearest quarter of a pound and was subsequently converted to kilograms. Height measurements were made with a solid platform anthropometer to the nearest tenth centimeter, with the subject standing erect with his head held in Frankfurt plane. Sitting height was measured with the subject sitting on a firm stool; the head was in the Frankfurt plane and the scapular and sacral regions were in contact with the anthropometer.

The bony diameters were measured using a spreading caliper. Measurements were read in centimeters to the nearest tenth.

The limb circumferences were measured with a steel measuring tape and read in centimeters. The upper arm circumference measurement was made half way between the acromion process of the scapula and the tip of the elbow with the arm hanging freely. The maximum circumference of the calf was reported.

All the skinfold measurements were made with a skinfold caliper representing a modification of Best's design (Best, 1953; Brozek, et al., 1963). This instrument exerts a constant pressure of 10 grams per square millimeter and estimates subcutaneous fat tissue to an accuracy of 0.5 millimeter. Three consecutive measurements were made at each site and then averaged.

Corrected diameters were calculated to estimate the muscular development of the limbs. This was done in accordance with the suggestion of Keys, et al. (1950) that if the limbs were assumed to be cylindrical, muscular development may be characterized by dividing the limb circumference by π (3.1416) and then subtracting the skinfold measurement obtained at the same level. The corrected diameter of both the upper arm and calf were, therefore, calculated on the basis of the formula:

$$d' = \frac{c}{\pi} - S$$

where:

- d' = corrected diameter
- c = limb circumference
- S = skinfold measurement

Lateral x-rays of the upper arm were taken from a six-foot distance and were employed as an additional means of assessing fat, muscle, and bone development in a random sample of 76 white children (38 boys and 38 girls) and 81 Indian children (43 boys and 38 girls). Four measurements of tissue widths were made along a horizontal line drawn at the same level at which the circumference and skinfold measurements were made. The following widths were measured: (1) breadth of the adipose layer and skin overlying the biceps; (2) breadth of the adipose layer and skin overlying the triceps; (3) breadth of the shadow of the humerus; and (4) breadth of the muscle, as the distance between the dorsal border of the triceps and the ventral border of the biceps minus breadth of the humerus. Measurements were made with a vernier caliper to the nearest 0.1 mm and a correction factor for magnification of the fat shadows was used according to a table devised by Novak (unpublished).

Results

NUTRITION—The mean dietary intake in calories, protein, fat and carbohydrates, (Table 1) was consistently higher for the Indian children than for their white peers. The only difference which proved to be statistically significant, however, was that found between the carbohydrate intake of white and Indian boys.

TABLE 1—Comparison of Dietary Constituents

	MALES		FEMALES	
	White (N = 8)	Indian (N = 8)	White (N = 8)	Indian (N = 8)
Total calories				
Mean	2317.8	3025.8	2014.2	2253.5
S.D.	551.1	968.8	309.5	461.0
Constituents in gm				
Protein				
Mean	78.5	91.4	68.9	74.1
S.D.	22.6	22.9	8.7	16.1
Fat				
Mean	108.6	134.2	84.6	98.7
S.D.	31.8	51.0	22.3	27.6
Carbohydrate				
Mean	256.6*	363.1*	244.3	269.7
S.D.	65.3	118.3	39.5	55.6
Constituents as percent of total calories				
Protein				
Mean	13.5	12.1	13.7	13.1
S.D.	2.1	2.3	1.3	1.8
Fat				
Mean	42.2	39.9	37.8	39.0
S.D.	4.2	5.5	5.3	4.1
Carbohydrate				
Mean	44.3	48.0	48.5	47.9
S.D.	5.7	4.5	4.3	3.4

* Difference between means significant at 0.05 level

ANTHROPOMETRY—Weight, Height and Sitting Height—Comparisons of mean weight, height, and sitting height of the racial groups according to sex and age level, (Table 2) revealed no statistically significant differences between the white and Indian children with one exception. As the exception to this rule, the white girls were significantly heavier than the Indian girls in the youngest age group (group A).

Bony Diameters—The mean bony diameter measurements (Table 3) showed no apparent racial differences in the average widths of the elbow or knee, but the Indian boys and girls in all three age groups were broader in the shoulders and hips than their white peers. The differences between the mean dimensions for the two racial groups, however, were not consistent at each age level.

The average shoulder width of the Indian boys was consistently greater than that of the white boys in their age group to a statistically significant degree; and the difference increased with increasing age. The Indian girls also were increasingly more broad shouldered than their white counterparts with increasing age. However, the difference between the races did not reach the level of significance until the girls reached age group B. The only difference between the hip measurements of the Indian

TABLE 2 — Comparison of Mean Weight, Height and Sitting Height Measurements

	Weight (in kg)		Height (in cm)		Sitting Height (in cm)	
	White	Indian	White	Indian	White	Indian
MALES:						
<i>Group A (6-8 years)</i>						
(N = 32 White 75 Indian)						
Mean	24.7	23.7	121.3	120.4	63.9	63.1
S.D.	4.0	3.2	5.6	5.5	3.0	3.1
<i>Group B (8-10 years)</i>						
(N = 35 White 86 Indian)						
Mean	30.1	29.9	132.9	131.5	68.5	67.8
S.D.	4.3	5.6	6.3	6.8	3.1	3.3
<i>Group C (10-13 years)</i>						
(N = 44 White 121 Indian)						
Mean	39.2	37.7	145.4†	143.3†	73.1	72.6
S.D.	5.9	7.4	6.9	7.3	2.6	3.5
FEMALES:						
<i>Group A (6-8 years)</i>						
(N = 45 White 73 Indian)						
Mean	23.8*	22.6*	120.6	118.9	62.8	62.3
S.D.	3.4	3.0	6.8	5.4	3.2	3.2
<i>Group B (8-10 years)</i>						
(N = 34 White 75 Indian)						
Mean	27.7	28.0	129.6	129.6	66.3	66.6
S.D.	4.4	4.3	6.2	5.7	3.4	2.8
<i>Group C (10-13 years)</i>						
(N = 67 White 107 Indian)						
Mean	37.5	38.0	144.3	143.9	72.8	72.7
S.D.	8.3	8.3	9.6	7.8	4.7	4.1

* Difference between means significant at 0.05 level

† Difference between means approaches significance at 0.05 level

TABLE 3 — Comparison of Mean Bony Diameter Measurements in cm.

	Bi-acromial		Bicristal		Bi-epicondylar Humerus		Bi-epicondylar Femur	
	White	Indian	White	Indian	White	Indian	White	Indian
MALES:								
<i>Group A (6-8 years)</i>								
Mean	26.7*	27.3*	19.2	19.6	5.0	5.0	7.5	7.5
S.D.	1.5	1.3	1.2	1.1	0.3	0.3	0.4	0.3
<i>Group B (8-10 years)</i>								
Mean	28.9*	29.7*	20.7	21.2	5.5	5.4	8.0	8.0
S.D.	1.5	1.7	1.0	1.3	0.2	0.4	0.4	0.5
<i>Group C (10-13 years)</i>								
Mean	31.2*	32.2*	22.7	23.0	5.9	5.9	8.5	8.6
S.D.	2.3	1.7	1.9	1.8	0.3	0.4	0.4	0.5
FEMALES:								
<i>Group A (6-8 years)</i>								
Mean	26.2	26.7	19.1	19.4	4.7	4.8	7.1	7.0
S.D.	1.7	1.4	1.7	1.1	0.3	0.3	0.3	0.4
<i>Group B (8-10 years)</i>								
Mean	28.4*	29.1*	20.3	20.8	5.1	5.1	7.4	7.5
S.D.	1.6	1.4	1.6	1.2	0.3	0.3	0.4	0.3
<i>Group C (10-13 years)</i>								
Mean	31.3*	32.3*	22.8*	23.8*	5.6	5.6	8.0	8.1
S.D.	2.0	2.1	2.0	1.8	0.4	0.3	0.4	0.4

* Difference between means significant at 0.05 level

and white children which was found to reach the level of statistical significance was the difference between the oldest group of Indian and white girls (group C).

Skinfolds — The means and standard deviations for the skinfold measurements (Table 4) showed average fat measurements of the limbs as being consistently greater in the white children than in the Indian children of matching ages. This difference was most striking in the calf, where all the mean fat measurement differences were found to be highly significant. ($p < 0.01$). For the youngest age level the difference between the means of the

upper-arm skinfold measurements of the two racial groups was significant in both sexes. In the two older age groups, significant differences in upper arm fat deposition between the races were observed only among males in the oldest group.

Assessment of the subscapular and iliac crest skinfold measurements showed that variations on racial lines between mean fat measurements in the upper and lower torso were not always in the same direction for the two sexes. The white males were again fatter on the average than their Indian counterparts. But this difference was

TABLE 4 — Comparison of Mean Skinfold Measurements in mm

	Upper-arm Dorsal		Subscapular		Iliac Crest		Calf	
	White		White	Indian	White	Indian	White	Indian
MALES:								
<i>Group A (6-8 years)</i>								
Mean	9.5*	6.7*	5.5*	4.7*	5.9	5.0	8.7*	5.8*
S.D.	2.9	1.9	2.1	1.6	2.6	2.6	3.3	1.8
<i>Group B (8-10 years)</i>								
Mean	9.0	7.9	5.3	5.5	6.4	5.9	9.2*	6.6*
S.D.	3.2	4.1	1.4	3.5	3.4	3.9	3.4	3.6
<i>Group C (10-13 years)</i>								
Mean	11.9*	9.4*	7.5*	6.2*	9.4	8.0	11.1*	7.8*
S.D.	4.1	4.8	3.1	3.2	4.7	5.1	4.4	4.2
FEMALES:								
<i>Group A (6-8 years)</i>								
Mean	10.0*	8.3*	6.2*	5.2*	7.6*	5.9*	10.2*	6.8*
S.D.	3.2	1.7	2.8	1.1	3.9	1.6	3.4	1.8
<i>Group B (8-10 years)</i>								
Mean	9.7	9.1	5.8	6.0	6.7	6.9	10.0*	7.7*
S.D.	3.7	2.8	3.1	2.5	3.5	3.1	4.1	2.9
<i>Group C (10-13 years)</i>								
Mean	12.1	11.3	7.4*	8.3*	8.4*	10.0*	12.9*	10.4*
S.D.	4.1	4.3	2.9	4.8	4.2	5.7	4.5	4.5

* Difference between means significant at 0.05 level

TABLE 5 — Comparison of Mean Limb Circumference and Corrected Diameter Measurements in cm

	Upper-Arm Circumference		Upper-Arm Corrected Diameter		Calf Circumference		Calf Corrected Diameter	
	White	Indian	White	Indian	White	Indian	White	Indian
MALES:								
<i>Group A (6-8 years)</i>								
Mean	18.9*	18.1*	5.1	5.1	25.0*	24.0*	7.1	7.0
S.D.	1.6	1.3	0.4	0.4	2.3	1.6	0.6	0.5
<i>Group B (8-10 years)</i>								
Mean	20.0	19.6	5.5	5.4	27.0*	26.2*	7.7	7.7
S.D.	1.7	2.4	0.4	0.5	1.9	2.2	0.5	0.5
<i>Group C (10-13 years)</i>								
Mean	22.2	21.4	5.9	5.9	30.3*	28.6*	8.5*	8.3*
S.D.	2.0	2.6	0.4	0.5	2.1	2.5	0.6	0.6
FEMALES:								
<i>Group A (6-8 years)</i>								
Mean	18.5*	17.9*	4.9	4.9	24.8*	23.5*	6.9	6.8
S.D.	1.7	1.4	0.4	0.4	1.8	1.5	0.4	0.4
<i>Group B (8-10 years)</i>								
Mean	19.2	19.1	5.1	5.2	26.6*	25.4*	7.5	7.3
S.D.	1.7	1.5	0.3	0.3	1.9	1.7	0.4	0.4
<i>Group C (10-13 years)</i>								
Mean	21.2	21.3	5.6	5.6	29.7*	28.5*	8.2	8.0
S.D.	2.2	2.5	0.5	0.5	2.7	2.5	0.7	0.6

* Difference between means significant at 0.05 level

statistically significant only for the mean subscapular measurements at age levels A and C. Initially the white females were fatter to a significant degree in the torso measurements for group A and significantly leaner in group C than their Indian peers. This phenomenon was detected both in the subscapular and iliac-crest fat deposits. There were no significant differences between either the subscapular or iliac-crest fat measurements of white and Indian girls in group B.

Limb Circumference and Corrected Diameters —

Means and standard deviations of limb circumferences and corrected diameters (Table 5) reveal the mean limb circumferences of the white children were, on the whole, larger than those of their Indian counterparts. The age groups between which the mean differences were found to be statistically significant parallel closely those in which the white children were found to be significantly fatter. Only analysis of calf measurements of the oldest age level of boys demonstrated that muscle plus bone, as assessed by corrected diameters, as well as fat contributed to the larger limb circumference in the white boys. At this same age level no significant difference was found between either mean upper arm circumference or corrected diameter measurements, though the skinfold measurements showed the white boys to be significantly fatter in

the upper arm. The reason for this inconsistency is not immediately apparent. It can be stated that the muscular development of the limbs, except in the calf of boys 10 through 12 years, was the same for white and Indian children.

X-Rays — Analysis of mean x-ray measurements of fat, muscle, and bone components of the upper arm (Table 6) basically verified the findings obtained from analysis of anthropometrical measurements in the same area.

White males in groups A and C had significantly larger skinfold measurements than their Indian counterparts, and were also found to have significantly larger dorsal and ventral fat measurements on x-rays. In Group A the white girls had significantly larger skinfold measurements than the Indian girls, although the difference was not significant at the five per cent level. Findings from the analysis of x-ray measurements of significant differences existing between the muscular development of white and Indian boys in group B (significantly larger muscle measurements for white boys) and the bone measurements of white and Indian boys in group C (larger bony diameter for Indian boys) were not consistent with findings from analysis of anthropometric measurements. Other than these noted differences, no significant racial

TABLE 6 — Comparison of Mean X-Ray Measurements of Tissue Components of the Upper Arm in mm

	Bone		Muscle		Dorsal Fat		Ventral Fat	
	White	Indian	White	Indian	White	Indian	White	Indian
MALES:								
<i>Group A (6-8 years)</i>								
(N = 10 White 12 Indian)								
Mean	15.4	15.6	42.6	39.3	9.0*	6.4*	6.4*	4.1*
S.D.	1.2	0.8	5.3	4.6	2.1	0.9	2.3	1.0
<i>Group B (8-10 years)</i>								
(N = 10 White 12 Indian)								
Mean	16.9	17.3	46.9*	40.5*	8.7	7.5	5.5	5.0
S.D.	1.6	1.5	5.4	5.2	2.4	2.2	2.8	1.9
<i>Group C (10-13 years)</i>								
(N = 18 White 19 Indian)								
Mean	17.5*	18.7*	49.5	48.1	9.6*	6.8*	6.5*	4.7*
S.D.	1.1	1.7	4.9	7.5	1.4	1.5	2.9	1.4
FEMALES:								
<i>Group A (6-8 years)</i>								
(N = 10 White 10 Indian)								
Mean	14.2	14.4	38.5	38.0	8.9	8.5	7.3	5.9
S.D.	1.2	1.6	4.0	4.2	1.8	1.4	2.3	1.6
<i>Group B (8-10 years)</i>								
(N = 10 White 10 Indian)								
Mean	15.1	15.9	42.8	41.9	9.1	9.0	6.0	6.0
S.D.	2.1	1.2	5.0	5.2	2.1	1.9	2.1	1.3
<i>Group C (10-13 years)</i>								
(N = 18 White 17 Indian)								
Mean	17.5	17.5	46.3	44.1	9.0	9.5	6.1	6.4
S.D.	1.8	1.6	6.7	6.2	1.3	2.9	1.7	2.6

* Difference between means significant at 0.05 level

differences were noted in muscle, fat or bone components which were not also found significant from anthropometric analysis.

Discussion

Because of the limited sample from which dietary information was obtained, only broad generalizations can be made about the impact of nutritional intake in the determination of the size and body composition of the children in the study. Since the nutritional components of diets appeared roughly equivalent for the samples of white and Indian children, except that Indian boys had a significantly higher carbohydrate consumption in absolute amount that did white boys, there seems to be no reason to assume that any major nutritional difference between the racial groups contributed to the fairly consistent differences noted in body composition. If anything, the diets of the Indian children may have tended to be superior to those of the white children in terms of absolute quantity of all the calculated constituents. Yet the white children were similar to the Indian children in height and weight, had either equivalent or greater muscle development, and tended on the whole to be fatter than their Indian peers. Indian children, on the other hand, generally had broader, more robust skeletons than their white counterparts.

If muscle measurements of the Indian children had been larger than those of their white peers, it might have been assumed that greater physical activity accounted for their relative leanness. Since this was not the case, the evidence suggests that there is a strong genetic component involved in the body composition. These findings further demonstrate how misleading it can be to assume similar body composition in two racial groups of similar height and weight.

References

- Area Redevelopment Administration. 1964. Public Law 87-27. 1961. Minnesota Laws. 1961. Chapter 629.
- BEST, W. R. 1953. An improved caliper for measurement of skinfold thickness. U.S. Army Research and Nutrition Laboratory Report No. 113. August 31.
- BROZEK, J., J. K. Kihlber, H. L. Taylor and A. Keys. 1963. Skinfold distributions in middle-aged American men. *Annals of the New York Academy of Sciences*. 110: 492-502.
- Committee on Nutritional Anthropometry, Food and Nutrition Board, National Research Council. 1956. Recommendations concerning body measurements for the characterization of nutritional status. *Human Biology*, 28: 111-123.
- CHURCH, H. M., and C. F. CHURCH. 1963. Food Values of Portions Commonly Used. J. P. Lippincott. Philadelphia. 9th ed.
- KEYS, A., J. Brozek, A. Henschel, O. Michelsen and H. L. Taylor. 1950. The Biology of Human Starvation. University of Minnesota Press. Minneapolis.
- KRAUS, B. 1954. Indian Health in Arizona. University of Arizona Press. Tucson. Chapter 8.
- STEGGERDA, M. and P. DENSEN. 1936. Height, weight and age for homogeneous groups with particular reference to Navajo Indians and Dutch white. *Child Development*. 7: 115-120.
- U. S. Department of Agriculture. 1963. Composition of foods: Raw, processed, prepared. Agriculture Handbook No. 8. Prepared by Bernice K. WATT and Annabel L. Merrill, et al. U.S. Government Printing Press. Washington, D.C.
- WISSLER, Clark. 1911. Measurements of Dakota Indian Children. *Annals of the New York Academy of Sciences*. 20. No. 7. Part II: 355-364.